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# Technology Opportunity

Technology Transfer & Partnership Office

TOP3-00176

## Polymer Cross-Linked Aerogels (X-Aerogels)

### Technology

The National Aeronautics and Space Administration (NASA) seeks to transfer technology for the development and production of polymer cross-linked aerogels (X-Aerogels). These are mechanically robust, highly porous, low-density materials, which are 3 times denser than native aerogels, but more than 300 times stronger.

### Benefits

- Technology offers materials for wider industrial use of aerogels
- Mechanically strong; not brittle like traditional silica aerogels
- Does not absorb moisture
- Combined strength and high porosity
- Simple processing compatible with that of traditional aerogels

### Commercial Applications

- Thermal insulating structural materials
- Acoustically insulating structural materials
- Catalytic supports for
  - Fuel reformers
  - Catalytic converters
- Dielectrics for fast electronics
- Filtration membranes
- Membranes for fuel cells and batteries
- Ballistic materials
- Optical sensors
- Aerospace components

### Technology Description

Aerogels are the lowest-density solid materials known and are made up of a nanoporous network of particles. Historically, aerogels have been used in numerous NASA space missions because of their low density and extremely high compressive strength. For example, they have been used as collectors of hypervelocity particles (Stardust Program), and as thermal insulators in extreme environments (Mars rovers). Because of their extremely low density, aerogels would have been very attractive materials for several terrestrial applications, however, they are very brittle and tend to absorb moisture from the environment, rendering them unattractive for most commercial applications.

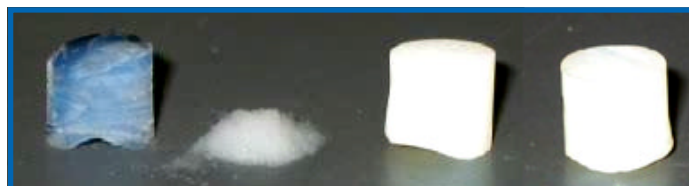


Figure 1– X-Aerogels (two monoliths on the right) survive high stress vibration; native silica aerogels (left) turn into powder.

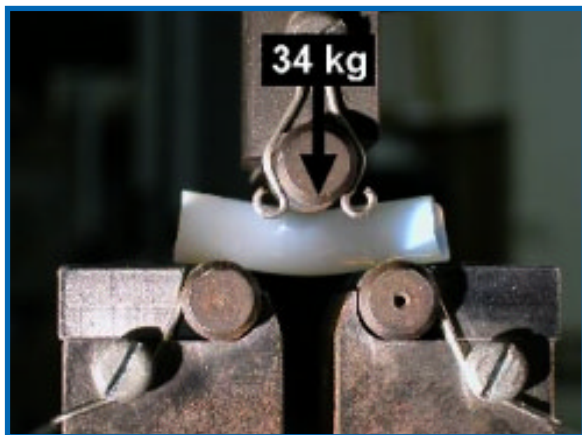
Researchers at NASA Glenn Research Center have resolved both of the primary problems common to aerogels: brittleness and hydrophilicity. They have developed a new approach for improving the strength and environmental stability of aerogels by coating conformally and crosslinking the individual skeletal aerogel nanoparticles with engineering polymers such as isocyanates, epoxies, and polyimides. For a nominal three-fold increase in density, the resulting materials have more than 300 times the mechanical strength and less than 10 times the hydrophilicity of native aerogels. In addition to these improved properties, polymer cross-linked aerogels are easy to fabricate and can be

machined. Immediate potential applications for these materials include lightweight insulation for cryogenic propellant tanks and structural materials for airframe and propulsion components.

The mechanism of cross linking has been carefully investigated and is based on two reactions: a reaction between the cross linker and the surface of the aerogel framework and a reaction propagated by the surface of the cross linker with itself. Aerogels cross-linked with isocyanates are strong enough to withstand the surface tension created when the low-vapor pressure liquids evaporate through their bulk. These materials can be dried by solvents without supercritical fluid extraction, leaving the nanoporous network entirely intact. Eliminating the supercritical fluid drying process may allow large monolithic aerogels to be manufactured in bulk quantities safely.

### Options for Commercialization

NASA Glenn Research Center is interested in working with industry and academia to further develop this material and identify new applications for X-Aerogels.



*Figure 2– X-Aerogels are mechanically strong, opening up many new applications where conventional aerogels were much too brittle.*

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### References

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### Key Words

Aerogel  
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